A Note on Typology and Evolution of Asian Rice Culture : Toward a Comparative Study of the Historical Development of Rice Culture in Tropical and Temperate Asia(<Special Issue>Twenty-Fifth Anniversary Issue)

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A Note on Typology and Evolution of Asian Rice Culture

——Toward a Comparative Study of the Historical Development of Rice Culture in Tropical and Temperate Asia——

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When I contributed two articles [Tanaka 1987a; 1987b] to a three-volume publication entitled *Ine no Ajia Shi* (*Asian History of Rice Culture*), I considered the possibility of combining them and comparing the historical development of rice culture between tropical regions like Southeast Asia and temperate regions like Japan and East Asia from both ecological and historical perspective. After publication, I had the chance to present my views orally at the ninety-eighth meeting of the Kansai Society of Agricultural History under the title of "Evolution of Rice Culture—Southeast Asia and East Asia," where I discussed the interrelationship between natural environment and rice-growing technologies in the two regions and presented some viewpoints for regional comparison of historical development in Asian rice culture.

This article is principally based on the discussion at this meeting and aims to present a framework for comparing evolutional processes of Asian rice-growing techniques from ecohistorical perspectives.

I "Agronomic Adaptation" and "Technological Adaptation"

By tracing the development of rice-growing technologies in Japan from the Tokugawa Era to the Meiji Era by the study of such technical components of rice culture as land reclamation, irrigation, cultivars, and farming techniques like land-tilling, fertilizer application, planting density, weed and pest control, etc., Arashi attempted to grasp the development process of rice culture as a "balanced ecological complex" [Arashi 1975: 11]. He explains that the balanced ecological complex is a total structure in which various components of rice culture like natural conditions, field conditions, input materials and farming techniques are totally interrelated, and he emphasizes that the final goal of historical studies of Japanese rice culture is to clarify the technological development in the light of this interrelationship among natural, social, economic and technological conditions.

The concept of a balanced ecological complex advocated by Arashi seems also to be useful in examining recent development of rice culture in Japan, for example, the rapid and epoch-making post-war development of production. It is well known that the productivity of Japanese rice culture increased during this period and that this increase was achieved through stepwise increase of rice yield per unit area. These stepwise increases of productivity are considered to have been realized by reciprocal and alternate application of two types of tech-

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nologies: one which enhances the plant's capacity of nutrient absorption, and one which enhances the effectiveness of fertilizer application. The former is the breeding of new rice varieties and the latter is the improvement of rice-growing techniques like fertilizer dressing, pest control, etc. [Igarashi 1961: 135]. Using the concept of balanced ecological complex, this remarkable increase of productivity can be said to have been achieved when these two types of technologies reached an ecologically balanced point at which they were harmoniously combined under a given environment.

The question now arises whether such dynamic development as was achieved in Japan also took place in Asian tropical rice-growing regions. Of course, the answer is yes: there are many regions in tropical Asia where such dynamic development was realized. On the other hand, there are also many regions where technological improvement seems to have stagnated rather than developed, and the conventional techniques remain pitted against the given natural conditions. However, even where development has stagnated, a balanced ecological complex can be found in the rice-growing techniques. This complex is established not in terms of productivity development but adaptation to the natural environment.

In this regard, it is useful to note two specific terms applied to different modes of development of rice culture in Southeast Asia, namely, "agronomic adaptation" and "technological adaptation." These were proposed by Ishii from the historical viewpoint to explain the relationship between state formation and rice-culture development in continental Southeast Asia, in particular, in the Chao Phraya basin in Thailand, and they were defined as follows:

> In some regions, people need only select rice varieties which are adapted to the given natural water conditions. The floodplain is one such region where people have mastered the rising floodwaters by selecting fast-growing varieties, for example, floating rice. In these regions, the knowledge required by the peasants is in a sense that of the agronomist, the knowledge to select appropriate varieties. This might be called "agronomic adaptation" to nature. In contrast, in regions having no readily available water sources, the peasants must devote their energies to utilizing rainwater or water from distant sources and to maintaining their supply. They must dig waterways, install water-lifting devices, build dikes, dam rivers, and construct reservoirs. This approach might be called a "technological adaptation." [Ishii 1978: 18]

According to Ishii, ancient states founded in the upper tributaries of the Chao Phraya river in intermontane basins of Northern Thailand were established as "quasi-hydraulic societies" in which royal authorities participated in controlling irrigation water by constructing weirs on streams, and the rice culture there was maintained by such river irrigation systems. In contrast, the medieval states, like Ayutthaya, in the floodplain of the Chao Phraya delta were founded on international trade rather than domestic rice culture, and rice culture there was practiced without any attempt to control water, merely by selecting appropriate rice varieties, floating rice, which were adapted to the water conditions of deltaic floodplain. Ishii describes the rice culture in the floodplain as follows: "People ceased their struggle against

the overwhelming power of the water in these regions and attuned their production methods to nature. Rather than trying to control the rapidly rising floodwaters that fill the backswamp, the peasants directed their efforts toward the selection of rice varieties that would grow fast enough to keep pace with the rise in the water level. The fruit of their efforts, 'floating rice', might well be called the masterpiece of the floodplain peasants" [*ibid.* 26]. Thus, he saw the former rice culture as being established through "technological adaptation," the latter through "agronomic adaptation."

The terms "agronomic adaptation" and "technological adaptation," which express the sharp contrast in the development of rice culture between the upper and lower reaches of the Chao Phraya basin, were favorably received by many historians because they were thought to be useful in order to understand the historical development of rice culture not only in Thailand but throughout Asian rice-growing countries.

However, some conceptual confusion arose after the frequent use of these terms by other historians and investigators, particularly when they would try to discuss technological development in rice culture. For example, when the historical development of rice culture in the Red River delta in Viet Nam was discussed in relation to state participation, large-scale installations such as dams and embankments constructed on the Red River were defined as technological adaptation [Sakurai 1980: 273]. In some cases, it was often indicated that aspects of both agronomic and technological adaptation were found in the same location in the course of the development [Miyajima 1986: 252]. Fukui, who studied the development of rice culture in the Chao Phraya delta, for instance, indicates that the development of rice culture was also achieved by technological adaptation. According to him, although the early development of rice culture in the delta was established through agronomic adaptation as Ishii mentioned, technological adaptation contributed to a greater extent in the modern period. He emphasizes that the development of rice culture includes both strategies of adaptation, agronomic and technological, whether in the intermontane basins or the deltaic floodplain [Fukui 1987: 327].

Thus, insofar as we use the very convenient and charming terms, agronomic adaptation and technological adaptation, such conceptual confusion may be unavoidable. It is therefore probably more appropriate to use other terminology in investigating the technological development of Asian rice culture so that we can concentrate the discussion on more technical, farming-technique-oriented aspects. Based upon such considerations, I have modified Ishii's terminology as follows: environment-adaptive technology instead of agronomic adaptation, and environment-formative technology instead of technological adaptation. In the premodern period, there were two types of technologies pitted against nature: one utilized the natural environment as it was without making any modification or change to the environment; and the other worked actively upon the natural environment to modify it and form a new environment for rice cultivation. In my terminology, the former is environment-adaptive technology and the latter is environment-formative technology.

These two modified terms are thought to be more useful for comparative investigation of the historical development of rice culture in various regions in Asian countries. For instance, in

some regions both environment-formative and environment-adaptive technologies were either reciprocally or simultaneously applied. People constructed the infrastructure, for example, by readjustment of field plots or installing irrigation facilities, then they began to adopt new techniques to grow rice which were more adaptive to the newly constructed infrastructure. In other regions, the environment-adaptive technologies alone had long been applied without any modification of their locational conditions. But in such regions, once an environment-formative technology was introduced and used successfully to change the infrastructure, people were obliged to change their former adaptive technologies to other forms more suited to the new environment.

II Typology of Rice Culture of Southeast Asia

Before comparing the development of rice culture in tropical and temperate Asia based on the modified terminology, it is necessary to understand what types of rice culture have been established in tropical Asia. In this regard, Takaya's classification [Takaya 1978: 6–34] seems to be suggestive. He classified rice culture in Southeast Asia into four types: the intermontane basin, the delta, the plain, and the tidal swamp type. The former three types are distributed in continental Southeast Asia, the last type in insular Southeast Asia. In addition to this classification, one more type, which can be called the volcanic foothill type following Takaya's nomenclature, is necessary in order to

Table 1 Typological Classification of Southeast Asian Rice Culture and Characteristics of Each Type

	Cultural Type	Physiography	Pattern of Rice Culture	Hydrology & Water Control	Intensity of Labor Input	Stability of Production
Continental SEA	Intermontane basin	River valley basin, fan	Transplanting, weeding by hand	Water control by weir, irrigation	Intensive	Stable
	Plain	Terrace, Plain	Broadcasting on dry land, intertillage and weeding by draft animals →expansion of transplanting	Dependent on rainfall →maintenance of watershed, tank irrigation	Extensive	Unstable
	Delta	Floodplain, levee, backswamp	Broadcasting on dry land (including floating rice) →expansion of transplanting	Adaptation to floods →excavation of canal network and pump irrigation from the canals	Extensive	Stable
Insular SEA	Volcanic foothill	Volcanic slopes, river valley basin	Transplanting and dibbling	Abundant water from springs and streams, water control by weir	Intensive	Stable
	Tidal swamp	Swamp forests on tidal flat	No tillage, dibbling and transplanting using a punching-out tool →expansion of transplanting	Adaptation to tidal-water intrusion →water control by sluice gate and canal excavation	Extensive	Unstable

Note) → indicates recent changes in rice-growing technologies.

grasp typologically the whole picture of traditional rice culture in Southeast Asia.

Table 1 presents the basic characteristics of these five types of rice culture, summarizing the physiography on which each was established, the typical farming techniques, the hydrological conditions and method of water control, the intensity of labor input and the stability of production. The distribution of these types is as follows: the intermontane basin type is found in the higher latitudes of continental Southeast Asia, such as the northern parts of Burma, Thailand, and Viet Nam; the plain type in central plain of Burma, Northeast Thailand and Cambodia; the delta type in the Irrawaddy, Chao Phraya, and Mekong deltas; the volcanic foothill type in highland Sumatra, Java, Bali, and mountainous areas in Sulawesi and the Philippines; and the tidal swamp type in lowlands of Sumatra, Borneo and the Malay peninsula around the Sunda Sea.

Leaving aside the intermontane basin and delta types, the characteristics of which have been explained in the foregoing section, I turn now to the plain type of rice culture. This is characterized by the scarcity of water supply: rice culture is completely dependent on rainfall. When the monsoon rain comes the first tilling starts using a cattle-drawn plough. Tilling and puddling is repeated several times in order to prevent the evaporation of soil moisture. Seeds are then broadcast, and once seedlings are standing inter-tillage with plough or harrow is practiced. This type of rice culture, which is very similar to dry farming in arid and semi-arid regions, was originally eatablished in the plains of India and introduced into the plains of Southeast Asia in ancient times. It is assumed that this introduction was successful because the plains of Southeast Asia were favored by similar climatic conditions to those of India. In other words, this type of rice culture was established in the Southeast Asian plains through the introduction of environment-adaptive technology.

Although broadcasting is the traditional seeding technique in the plains, transplanting is also widely practiced in the present-day plains. It is not clear when transplanting was first introduced into the plains, but the introduction might have been closely related to changes in water control technology. In early times people were totally dependent on rainfall and rice was grown under very unstable conditions. To cope with the instability of rainfall, new technologies to supply additional water were required. These were the technologies for constructing reservoirs and tanks to catch and keep the rainfall in the watersheds where the rice fields are located. With the transformation of original environment through the introduction of the watershed-control technology, which was environment-formative, more stable and productive techniques were required to grow rice under the new, transformed conditions. Thus transplanting began to expand as a new environment-adaptive technology in the plains of Southeast Asia.

In regard to such successive introduction of different types of technology as described above, it is worth noting similar recent technological changes in the delta-type rice culture. In the Chao Phraya delta, rice culture has seen two major changes since the Greater Chao Phraya Project was completed. These are the shift from broadcasting to transplanting of traditional rainy-season rice and the establishment of double cropping of rice through the introduction of dry-season rice grown by transplanting on

irrigated land [Takaya 1987: 168–175]. These changes mean that the former environment-adaptive technologies such as floating rice and broadcasting were replaced by different adaptive technology in a new, transformed environment. In this case, irrigation and drainage works constructed under the project were environment-formative technologies, and transplanting and dissemination of new varieties were environment-adaptive technologies successively adopted.

The tidal swamp and volcanic foothill types of rice culture distributed in insular Southeast Asia are characterized by their abundance of rainfall, since they were established in a tropical rainforest climate. For water control, neither type requires large-scale engineering works like dams and large weirs. This characteristic can be observed most typically in the volcanic foothill type. Volcanoes or high mountains function as water reservoirs. The rainfall stored in volcanoes and mountains is gradually supplied through such year-round water resources as springs and streams. This abundant water and the fertile soil derived from volcanic ashes provide some of the best conditions for rice-growing in Southeast Asia. People need not do more than make practical use of these favourable conditions. Under these conditoins, they have established elaborate rice-growing systems in which communal water-management groups are organized. The most typical examples can be seen in central Java and Bali [Kaida 1987: 82–84].

These elaborate rice-growing systems were established through the accumulation of small-scale engineering works such as terraced fields climbing the slopes and waterways traversing them. This mode of infrastructure construction for rice fields is similar to that in the intermontane basin type, in which small-scale weirs and waterways have developed into gravitational irrigation networks and fostered elaborate rice-growing techniques. The scale of river systems in both volcanic foothills and the intermontane basins is small enough that they can be controlled by small communities, and the irrigation systems established there are also small enough for a communal organization to maintain. It was in such locations that the environment-formative technologies were applied in the premodern period.

In such an elaborately constructed space, rice-growing techniques have also developed in the direction of intensive land and labor use. Terraced fields where irrigation and drainage are easy to control are used for rice-growing in the rainy season and for upland crops in the dry season, and double cropping of rice is also practiced. Like land use, labor input is also intensive. Although cattle-drawn implements like the plough and harrow are found throughout insular Southeast Asia, manpower tilling with a hoe is more common. This labor-intensive farming can achieve deeper tillage than ploughing and neat preparation of dikes and fields, and this consequently allows permanent and efficient realization of the potential productivity of the land.

Such intensive farming techniques were established as an adaptive technology to the rice fields which were transformed by environment-formative technology. In other words, land- and labor-intensive techniques were established as a technology suitable to well-formed rice fields provided with neatly arranged irrigation systems. It can be said that the volcanic foothill type provides a good example

of the development of rice culture under the interrelationship between environment-formative and enviroment-adaptive technologies.

In contrast to the volcanic foothill type, the tidal swamp type of rice culture is less intensive in terms of both land and labor utilization. The coastal zones of insular Southeast Asia, particularly the areas facing the Sunda Sea, are covered with a thick layer of peat soil whether their original vegetation was fresh-water swamp forest or tidal swamp forest. Rice fields in such areas are susceptible to such problems as saline soil, acid sulphate soil and high tide. To grow rice in these areas, specific techniques to overcome these problems are indispensable. It is the tidal swamp type of rice culture that achieves this.

In the coastal zones, the water level of rivers is affected by daily tidal movements. The overlying layer of fresh-water in the rivers becomes deeper in the rainy season and when this layer is raised by the high tide it can be utilized to irrigate rice fields. The fresh-water is drawn into the fields at high tide through excavated waterways, and it is kept in the fields at low tide by closing a small watergate installed in each field plot. Fields are prepared not by tilling with plough or hoe but simply by cutting grass and reeds with a long knife called *parang*. The thick grass and reeds that grow during the fallow period are cut from the bottom, piled into small heaps, and left to rot. The thick vegetation covering the sod soil does not allow the plough or hoe to be operated. Even if tillage were possible, it would accelerate drawback through the decomposition of peat. After the land preparation without tillage, rice seeds are dibbled in or seedlings are transplanted into holes punched out with a special tool. It is in this type of rice culture that the double transplanting method is commonly practiced. Once planting is complete, nothing except occasional care of water control is done untill the harvest time. As in the delta-type rice culture, where the people "attuned their production method to nature" [Ishii 1978: 26], the tidal swamp type was also established by adapting techniques to specific conditions such as thick vegetation, tidal movement and problem soils.

Of five types described above, it is in the intermontane basin and volcanic foothill types that water-control technology was elaborately developed, that locational conditions were changed greatly, and that finally the landscape of the rice-growing space was neatly transformed with premodern technology. In these types, environment-formative technology was consecutively applied, and this resulted in intensive land use and farming techniques. On the other hand, development took a different direction in the three other types, where techniques adaptive to the given environments were continuously applied rather than techniques that would change the locational conditions. Rice fields were reclaimed with only slight modification of natural conditions and the consecutive accumulation of environment-formative technologies did not take place. Just as the common characteristic of these types was the adaptation of rice-growing methods to the given hydrological conditions, so has the rice culture itself been predominantly environment-adaptive compared to the first two types mentioned above.

In conclusion, premodern rice culture developed in two modes in Southeast Asia: one developed intensive rice-growing techniques to a considerable extent, through the reciprocal

and alternate applications of environment-formative and environment-adaptive technologies; the other developed them to a much lesser extent, though a "balanced ecological complex" was established through the application of environment-adaptive technologies. It was only with the introduction of modern engineering technologies, which occurred very recently compared to the long history of rice culture in Asia, that large-scale transformation of locational conditions began in the latter type of rice culture.

III Development of Japanese Rice Culture and Its Characteristics

In terms of the typological classification of rice culture in Southeast Asia, Japanese rice culture, which developed the most intensive and productive technology in Asia, can be classified as being of the intermontane basin type, not only because of the similar characteristics of its rice-growing techniques but also because of its genealogy.

The development of rice-culture in premodern Japan is characterized by a rapid cycle of reciprocal and alternating applications of environment-formative and environment-adaptive technologies. Like the intermontane basin type in Southeast Asia, Japanese rice culture was also established through the consecutive accumulation of environment-formative technologies. However, this accumulation occurred more frequently and more rapidly in premodern Japan than in premodern Southeast Asia. The rice field, which was an artificially constructed device for production was consecutively fitted with new devices providing additional, improved infrastructure. In response to the improvement of infrastructure, more intensive rice-growing techniques were also introduced, and the rapid cycle of development was perpetuated.

The rapidity of this cycle in Japanese rice culture can be partly ascribed to its genealogy. The intermontane basin type is one of predominant rice cultures in Asia, distributed from the northern parts of continental Southeast Asia through China and Korea to Japan. Since Japan is located at the northeastern edge of this vast area of distribution, it was probably the last place reached by the wave of dispersal of this rice culture. If this is true, then this rice culture must have undergone considerable technological development, probably in China, before it reached Japan. Recent archaeological excavations at the Nabatake site in northern Kyushu revealed the existence of neatly arranged rice fields, irrigation channels, weirs and various forms of wooden farming tools in the earliest rice culture (fourth century B.C.) in Japan. This evidence suggests that the original form of rice culture adopted in Japan had already been developed to a considerable extent by the application of both environment-formative and environment-adaptive technologies.

Following the introduction of rice culture to Japan, continuous technological development is considered to have been achieved under the general influence of China, though evidence from the ancient and medieval periods is too scant to allow the complete process to be deduced. Engineering technologies related to irrigation, water control, reclamation and construction of infrastructure of rice fields, and mechanical technologies related to improvements of farm tools are typical examples show-

ing Chinese influence. However, Japanese rice culture began to develop independently from Chinese influence in the Tokugawa Era. In this period Japanese rice culture developed the peculiar characteristics that paved the way for further development in the modern period beginning in the middle of the Meiji Era.

The characteristics of the Japanese rice-growing techniques developed in the premodern period can be summarized as intensiveness in land and labor use, skill-orientedness in farming techniques and evenness in extension and dissemination of technology [Tanaka 1987b: 313–333]. The most important features of the background to this development were the consolidation of feudal power based on the rice economy and the development of commerce and manufacture in urban and suburban areas. Tokugawa Japan saw agricultural expansion from the time of its foundation. Local powers supported the reclamation of new rice fields and recommended the cultivation of commercial or industrial crops to increase their revenues. Such expansion often threatened the former "balanced ecological complex," since limited land and water resources had to bear this expansion. The expansion of the commercial economy also required the farmers to change their rice-growing techniques. Increased use of purchased fertilizers and the improvement of planting, weeding and pest-control methods in accordance with this increase required them to establish more labor-intensive farming.

Commercialization brought with it faster circulation of production materials and information of agricultural technologies. The changes in rice-growing techniques were also closely related to social changes. Information and knowledge about new techniques were distributed and introduced quickly and evenly from place to place. Superior varieties at first grown locally were transferred by farmers to various areas and became the leading varieties commonly grown in vast regions. Information on new techniques such as farm tools, fertilizers and their use was also disseminated. Treatises on advanced, improved farming methods were published, and they were read by farmers, some of whom wrote down their own farming experiences to propagate this information to the public and their descendants. Such circulation of information served to reduce differences in production levels both between areas and between individual farmers. Such evenness in terms of technological standards was also a notable characteristic in Tokugawa Japan.

To cope with the tight control of Tokugawa rulers over land-tax, farmers had to make efforts to grow rice in more intensive and productive ways. Besides the political situations, the expansion of commercial crops and the reclamation of new fields, as described above, prompted the farmers to raise the productivity of rice cultivation within the framework of limited resources of land and water. This situation led to the development of skill-oriented technology in rice culture. Farmers organized a tight community in each village (*mura*) to control and manage their land and water resources, and consequently to regulate rice cultivation under a system of mutual control and supervision in the community. Working hard became a virtue for individual farmers not only because of rulers' edicts but also because of the mutual control among the farmers themselves. Such psychological pressure was compounded by the constant tension between villages over distribution and utilization of water resources, spurring farmers

to further efforts to improve their rice-growing methods. Experienced and skillfull farmers were admired and respected, and they led the community and propagated their elaborate techniques among the villagers. Villagers also competed with each other in farming ability, and led them to seek better and more sophisticated techniques. The employment of skill-oriented techniques, one of the characteristics of present Japanese rice culture, arose under such circumstances in Tokugawa Japan.

IV Toward a Comparison—Concluding Remarks

The fast and frequent repetition of the cycle of environment-formative and environment-adaptive technologies in Japanese rice culture can mostly be ascribed to the specific characteristics developed in the Tokugawa Era. Similar development was not, however, seen to any great extent in tropical Asian rice culture, even in the intermontane basin or volcanic foothill types of rice culture in Southeast Asia, which had basically similar characteristics in technological development to those of Japanese rice culture.

The areas where these two types of rice culture were predominant underwent different socioeconomic changes in the period when Japan was developing its autonomous, rice-growing society. These were colonization and the development of commercial economy of rice under its influence. In the volcanic foothills, particularly in Java, where under the Culture System the colonial power forced farmers to cultivate commercial crops other than rice, the development of rice culture tended to stagnate. In the intermontane basins rice culture also stagnated because the rice culture in the lower streams, that is, delta-type rice culture, had attracted the colonial powers and farmers of the time by its potential to produce huge quantities of rice. Due to the expansion of rice cultivation in the deltas prompted by the emergence of an international market in rice, the intermontane basins were relegated to the hinterland of rice culture.

Only very recently, particularly since the late 1960s at the earliest, has significant technological transformation begun in tropical Asian rice culture. As shown in Table 1, the recent changes are characterized by the development of infrastructures and the introduction of intensive growing techniques like transplanting. These changes indicate that the different types of rice culture in tropical Asia are moving in the same direction of technological development as that taken by Japanese rice culture. In the areas where the volcanic foothill and intermontane basin types of rice culture were predominant, this transformation is expected to be realized successfully and without difficulty because of the similarity in the characteristics of their rice-cultural development. However, what types of "balanced ecological complex" will be formed is still in question in the deltas, tidal swamps, and other areas originally characterized by a different type of technological development. This means, in other words, that many areas of tropical Asia remain where location-specific development has to be investigated rather than monotonous introduction of the intensive, modern technologies.

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